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WGI Discussion Papers

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Abstract

The paper provides an explanation of the mechanisms underlying trade roots of the contagion effects emanating from the recent turmoils. It is argued that under demand uncertainty risk averse behavior of firms provides a basis for international trade. The paper shows by means of a simple two-country model that risk averse firms operating in perfectly competitive markets with uncertainty of demand tend to diversify markets what gives a basis for international trade in identical commodities even between identical countries. It is shown that such trade may be welfare improving despite efficiency losses due to cross-hauling and transportation costs. The analysis reveals that change of the expectations concerning market conditions caused by the turmoil in the neighbor country (i.e., shift in the perception of market conditions) may lead to macroeconomic destabilization (increase in price level and unemployment, worsening of terms of trade, and deterioration of trade balance).

Keywords: Crises propagation, contagion, reasons for trade, intra-industry trade, demand uncertainty, risk aversion, market diversification

JEL Classification: F3, F4, F100, D800

1 Introduction

The recent crisis in Brazil and other emerging market economies has once again raised the question of contagion effects. The term contagion refers to a situation where a crisis in one country conceivably triggers a crisis elsewhere for reasons unexplained by macroeconomic fundamentals, perhaps because it yields shifts in market sentiment or changes in the interpretation given to existing information (an increased perception of risk).

A typical transmission mechanism of contagion discussed in the literature focuses on trade linkages (see, for example, Eichengreen, Rose and Wyplocz 1996). The idea behind this approach is that an attack-induced devaluation in one country enhances its competitiveness, yielding trade deficits and declining reserves for its trade partners, making their currencies more vulnerable. The current paper does not focus on currency and exchange rates, but instead aims to reveal the relationship between the change in the expectations concerning market conditions caused by the turmoil in the neighbor country (i.e., change to interpretation of existing market information) and macroeconomic destabilization it can cause.

In order to explain this effect we develop a model of trade based on demand uncertainty and risk averse behavior of firms. In particular, we show that risk averse firms operating in perfectly competitive markets with uncertainty of demand tend to diversify markets what gives a basis for international trade in identical commodities even between identical countries. It has to be mentioned that the basic idea of the trade model: risk reduction by market diversification is well established in international capital markets and known as a theory of portfolio choice with risk aversion. The originator of the theory – James Tobin – described its fundamental concept as:

"Don't put all eggs in one basket". In the analysis presented in the paper we introduce transportation costs explicitly, and interpret the model in international trade setting. In particular, we show that when transportation costs are small enough and an economy is opened to international trade, producers can reduce the risk they face by placing some "eggs" in additional foreign "basket". This reduction in risk is the basic motive for international exchange. Furthermore, we show that such trade may be welfare improving despite efficiency losses due to cross-hauling and transportation costs. Finally, focus is laid on the effects of shift in the perception of market conditions resulting from the disturbances in a neighbor country on selected macroeconomic indicators. In particular, we reveal that even not realized shift in expectations (or an increase in variability of demand) may worse basic macroeconomic fundamentals (i.e., increase price level and unemployment, worse terms of trade and deteriorate trade balance).

The paper is organized as follows. In Section 2 the trade model is presented. Section 3 characterizes free trade equilibrium (international exchange and welfare effects). Section 4 shows how the change in the perception of market condition can influence values of basic macroeconomic fundamentals. Section 5 draws some conclusions.

2 The model of trade

The traditional approach to intra-industry trade is to assume that such trade arises because slightly different commodities are produced and traded to satisfy consumer´s for variety (see Krugman, 1980). Brander (1981) shows that there are reasons to expect two-way trade even in identical products, due to strategic interactions among firms operating in non-competitive markets. What is not so widely recognized is that there are reasons to expect international trade in identical commodities (i.e., within a single industry) even if markets are perfectly competitive. The analysis below makes a modest contribution to the theory of trade between similar or even identical countries, such as trade within the European Union. Accordingly countries are assumed to be identical and the pattern of trade is determined by the interaction of demand uncertainty, risk aversion and perfectly competitive behavior of firms.

2.1 Markets

There are two identical countries, the home country and the foreign country. In each country a single commodity can be produced and supplied to perfectly competitive markets. Markets are separated. Countries are identical, but in both of them there is uncertainty about market demand. In particular, we assume that two states of nature (*S1* and *S2*) can occur independently in each country. Assume for the time being that in each country probability of state *S1* is q, and probability of state *S2* is $1-q$. Market demands in each particular state are assumed to be identical in both countries. Denote inverse market demands at state *S1* and *S2* correspondingly as $D^{-1}(X)+\lambda$ and $D^{-1}(X)-\lambda$ ($\lambda>0$, $dD^{-1}(X)/dX<0$), where X ($X \geq 0$) is the total quantity supplied to the market.

2.2 Firms

The cost function of the firm in the model is given by

$$TC(x+x^{\circ}) = C(x+x^{\circ}) \tag{1}$$

where *TC* is a total cost, x and x° denote correspondingly the volume of output supplied to domestic market and exported $(x, x^{\circ} \geq 0)$, and *C* denotes constant marginal cost (no fixed cost is assumed). Transport costs are borne by producers. Per unit transport cost equals t ($t>0$).

In an uncertain world, we assume that the decision on the volume of output to be produced must be taken prior to the sales date, at which the actual market demand becomes known. The firm´s beliefs about market demand are given by the probabilities of state *S1* and *S2*. The firm is assumed to be unable to influence this distribution (e.g., predict market demand). Moreover, we assume that firms are managed according to the wishes of their owners who are typical asset holders, and that the decisions in each firm are made by a group of decision-makers with sufficiently similar preferences to guarantee the existence of a group-preference function, representable by a von Neuman-Morgenstern utility function $U(\cdot)$ such that $U'>0$ and $U''<0$, implying risk averison.[1]

2.3 Individual output decisions

For the sake of clarity we assume that each firm makes its output decision with sole regard for short-run profits and does not consider the relationship between this output policy and long-run policies for investment and finance[2]. Each firm takes the market prices in each particular state as given and must decide (before the real market price becomes known) how much of the commodity to produce for domestic consumption and how much for the export. Thus, each firm's profits can be defined as:

$$\pi_1(x,x^{\circ}) = (P+\lambda)x + (P+\lambda)x^{\circ} - C(x+x^{\circ}) - tx^{\circ}, \tag{2}$$

if state *S1* occurs in both countries;

$$\pi_2(x,x^{\circ}) = (P+\lambda)x + (P-\lambda)x^{\circ} - C(x+x^{\circ}) - tx^{\circ}, \tag{3}$$

if state *S1* occurs in home country and state *S2* occurs in foreign country;

$$\pi_3(x,x^{\circ}) = (P-\lambda)x + (P+\lambda)x^{\circ} - C(x+x^{\circ}) - tx^{\circ}, \tag{4}$$

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[1] Sandmo (1971) and Leland (1972) provide justification for this assumption.

[2] A more complete model would make it necessary to draw up a much larger and more detailed list of assumptions about the economic environment of the firm than is needed for the present paper.

if state *S2* occurs in home country and state *S1* occurs in foreign country;

$$\pi_4(x,x^\circ) = (P-\lambda)x + (P-\lambda)x^\circ - C(x+x^\circ) - tx^\circ, \tag{5}$$

if state *S2* occurs in both countries (to simplify the notation we will skip the arguments (x, x°) when referring to the profit functions specified above). Taking the above into account, the firm takes prices as given and maximizes expected utility from profit:

$$E[U(\pi)] \equiv q^2 U(\pi_1) + q(1-q)U(\pi_2) + q(1-q)U(\pi_3) + (1-q)^2 U(\pi_4) \tag{6}$$

with respect to x and x° $(x, x^\circ \geq 0)$, where E is the expectations operator. Since for the risk averse utility function (i.e., $U'(\pi)>0$ and $U''(\pi)<0$) the objective function (6) is strictly concave for any x and x° $(x, x^\circ \geq 0)$, there exists a single pair $(\tilde{x}, \tilde{x}^\circ)$ for which the objective function is maximized.[3]

2.4 Industry

The industry in both countries is competitive. Since under uncertainty of demand in competitive equilibrium there is a finite number of risk averse firms (N) operating in the market,[4] total volume of output supplied to the market of any country can be represented as

$$\tilde{X}(P) = N \cdot [\tilde{x}(P) + \tilde{x}^\circ(P)]. \tag{7}$$

Since the total volume of output supplied depends on the number of firms (N) in the industry, the equilibrium market prices also depend on N (i.e., $P = P(N)$), and consequently, an equilibrium volume of output supplied to the market by each individual firm can be considered as a function of N, i.e., $\tilde{x}(N)$ and $\tilde{x}^\circ(N)$. The number of firms, N, in the industry is determined by free entry and exit, such that in equilibrium the expected utility of being in the industry is equal to the expected utility of some benchmark activity b ($b>0$). This yields the industry equilibrium condition[5]

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3 Note that for any pairs (x_1, x_1°) and (x_2, x_2°), such that $(x_1, x_1^\circ) \neq (x_2, x_2^\circ)$, and $x_1, x_2, x_1^\circ x_2^\circ \geq 0$, and for any $\gamma \in (0,1)$,

$\pi_i[\gamma x_1 + (1-\gamma)x_2, \gamma x_1^\circ + (1-\gamma)x_2^\circ] = \gamma\pi_i(x_1, x_1^\circ) + (1-\gamma)\pi_i(x_2, x_2^\circ)$, and, therefore,

$U\{\pi_i[\gamma x_1 + (1-\gamma)x_2, \gamma x_1^\circ + (1-\gamma)x_2^\circ]\} = U[\gamma\pi_i(x_1, x_1^\circ) + (1-\gamma)\pi_i(x_2^\circ, x_2^\circ)] >$

$> \gamma U[\pi_i(x_1, x_1^\circ)] + (1-\gamma)U[\pi_i(x_2, x_2^\circ)]$

due to strict concavity of the utility function. Since $E\{U[\pi(x,x^\circ)]\}$ is a linear combination of $U[\pi_i(x,x^\circ)]$, where $i=1,2,3,4$; $E\{U[\pi(x,x^\circ)]\}$ is also strictly concave function of $x, x^\circ (x, x^\circ \geq 0)$.

4 See Ghosal (1996) for empirical evidence.

5 See Appelbaum and Katz (1986).

$$E\{U[\pi(\tilde{x}(P),\tilde{x}^{\circ}(P))]\}-b=0\,. \tag{8}$$

3 Free trade equilibrium

3.1 International exchange

Suppose that the total equilibrium volume of output W supplied to the market is positive i.e., $\tilde{X}>0$, then an equilibrium output of a single firm $\tilde{\chi}=\tilde{x}+\tilde{x}^{\circ}=\tilde{X}/N$ is also positive ($\tilde{\chi}>0$). Representing $x^{\circ}=\tilde{\chi}-x$, substituting into (2)-(5) and differentiating (6) with respect to *x*, we get

$$\begin{aligned}\frac{d}{dx}E[U(\pi)] &= \left[q^2\frac{dU}{d\pi}(\pi_1)+q\,(1-q)\frac{dU}{d\pi}(\pi_2)+q\,(1-q)\frac{dU}{d\pi}(\pi_3)+(1-q)^2\frac{dU}{d\pi}(\pi_4)\right]\cdot t\\ &\quad +2\lambda q\,(1-q)\left[\frac{dU}{d\pi}(\pi_2)-\frac{dU}{d\pi}(\pi_3)\right]\end{aligned} \tag{9}$$

Note that $\pi_2(x=0)<\pi_3(x=0)$. Consequently, $dU/d\pi(\pi_2)-dU/d\pi(\pi_3)>0$ and $d/dx\,E[U(\pi)]>0$, for $x=0$ and $x^{\circ}=\tilde{\chi}$. Therefore, the pair ($x=0, x^{\circ}=\tilde{\chi}$) cannot be optimal, since for any small $\Delta x>0$, the pair ($x=\Delta x, x^{\circ}=\tilde{\chi}-\Delta x$) gives a higher expected utility level). On the other hand, $\pi_2(x=\tilde{\chi})>\pi_3(x=\tilde{y})$. Consequently, for $x=\tilde{\chi}$ and $x^{\circ}=0$ $dU/d\pi(\pi_2)-dU/d\pi(\pi_3)<0$, and for sufficiently small *t*, $d/dx\;E[U(\pi)]<0$. Thus, for sufficiently small *t* the pair ($x=\tilde{\chi}, x^{\circ}=0$) cannot be optimal, since there exists such a pair ($x=\tilde{\chi}-\Delta x$, $x^{\circ}=\Delta x$), where $\Delta x>0$, for which the value of the objective function is higher.

Consequently, we conclude that for sufficiently small *t* each firm supplies to both markets (i.e., $\tilde{x}>0$ and $\tilde{x}^{\circ}>0$). This means that if transportation costs are small enough, an equilibrium in the market with uncertain demand involves international trade in spite of the fact that both countries produce exactly the same commodity in perfectly competitive environment, and there is an obvious loss due to transport cost. If countries are identical the situation in the foreign country is symmetric to that in the home country. The firm located in the home country exports to the foreign country and produces for its domestic market, while the firm in the foreign country exports to the home country and produces for its domestic market. In other words, the market equilibrium involves trade in spite of the fact that both countries produce exactly the same commodity in perfectly competitive environment, and there is an obvious loss due to transport cost.

3.2 Welfare effects

Consumer surplus. Expected consumer surplus equals

$$E[CS] = \int_{P}^{+\infty} D(z)dz \tag{11}$$

Taking the derivative of (11) with respect to *t* (at $P = \widetilde{P}$, where $\widetilde{P}$ denotes equilibrium market price), we get:

$$\frac{d}{dt}E[CS] = \frac{d}{dt}\int_{\widetilde{P}}^{+\infty} D(z)dz = -D(\widetilde{P})\frac{d\widetilde{P}}{dt}. \tag{12}$$

The equilibrium values, $\widetilde{x}$, $\widetilde{x}^{\circ}$ and $\widetilde{P}$, satisfy the following conditions

$$\frac{\partial}{\partial x}E[U(\pi)] = 0 \tag{13}$$

$$\frac{\partial}{\partial x^{\circ}}E[U(\pi)] = 0 \tag{14}$$

$$E[U(\pi)] - b = 0 \tag{15}$$

Consider the equilibrium values $\widetilde{x}$, $\widetilde{x}^{\circ}$ and $\widetilde{P}$ as functions of *t* and differentiate (15) with respect to *t*, we get

$$\frac{d}{dt}E[U(\pi)] \equiv \frac{\partial}{\partial x}E[U(\pi)]\frac{d\widetilde{x}}{dt} + \frac{\partial}{\partial x^{\circ}}E[U(\pi)]\frac{d\widetilde{x}^{\circ}}{dt} + \frac{\partial}{\partial P}E[U(\pi)]\frac{d\widetilde{P}}{dt} + \frac{\partial}{\partial t}E[U(\pi)] = 0 \tag{16}$$

Taking into account (13) and (14), then (16) reduces to

$$\frac{d}{dt}E[U(\pi)] = \frac{\partial}{\partial P}E[U(\pi)]\frac{d\widetilde{P}}{dt} + \frac{\partial}{\partial t}E[U(\pi)] \tag{17}$$

Plugging

$$\frac{\partial}{\partial P}E[U(\pi)] = \left[q^2U'(\pi_1) + q(1-q)U'(\pi_2) + q(1-q)U'(\pi_3) + (1-q)^2U'(\pi_4)\right]\cdot(\widetilde{x} + \widetilde{x}^*) \tag{18}$$

and

$$\frac{\partial}{\partial t}E[U(\pi)] = -\left[q^2U'(\pi_1) + q(1-q)U'(\pi_2) + q(1-q)U'(\pi_3) + (1-q)^2U'(\pi_4)\right]\cdot\widetilde{x}^* \tag{19}$$

into (17) and rearranging it follows immediately that

$$\frac{d\tilde{P}}{dt} = \frac{\tilde{x}^{\circ}}{\tilde{x} + \tilde{x}^{\circ}} \tag{20}$$

and finally

$$\frac{d}{dt}E[CS] = -D(\tilde{P})\frac{\tilde{x}^{\circ}}{\tilde{x} + \tilde{x}^{\circ}} \tag{21}$$

Therefore, the expected consumer surplus falls if transportation cost increases.

Producer surplus. Let $\tilde{\pi}_i = \pi_i(\tilde{x}, \tilde{x}^{\circ})$, for *i=1,2,3,4*. In equilibrium the expected producer surplus is determined as

$$E[PS] = \tilde{N}[q^2\tilde{\pi}_1 + q(1-q)\tilde{\pi}_2 + q(1-q)\tilde{\pi}_3 + (1-q)^2\tilde{\pi}_4] \tag{22}$$

Differentiating (22) with respect to *t* leads to

$$\frac{d}{dt}E[PS] = \frac{d\tilde{N}}{dt}E[\pi] + \tilde{N}\frac{d}{dt}E[\pi] \tag{23}$$

Since $\tilde{N} = \tilde{X}/(\tilde{x} + \tilde{x}^{\circ})$, we have

$$\frac{d\tilde{N}}{dt} = \frac{\dfrac{d\tilde{X}}{dt}(\tilde{x} + \tilde{x}^{\circ}) - \tilde{X}\dfrac{d(\tilde{x} + \tilde{x}^{\circ})}{dt}}{(\tilde{x} + \tilde{x}^{\circ})^2}. \tag{24}$$

Taking into account that $\tilde{X} = D(\tilde{P})$, differentiating and rearranging yields

$$\frac{d\tilde{N}}{dt} = \frac{\dfrac{dD}{dP}(\tilde{P})\tilde{x}^{\circ} - D(\tilde{P})\left(\dfrac{d\tilde{x}}{dt} + \dfrac{d\tilde{x}^{\circ}}{dt}\right)}{(\tilde{x} + \tilde{x}^{\circ})^2}. \tag{25}$$

Taking into account (2)-(5) and rearranging we have:

$$E[\tilde{\pi}] = \left[q(\tilde{P} - C + \lambda) + (1-q)(\tilde{P} - C - \lambda)\right]\tilde{x} + \left[q(\tilde{P} - C - t + \lambda) + (1-q)(\tilde{P} - C - t - \lambda)\right]\tilde{x}^{\circ}. \tag{26}$$

Differentiating (26) with respect to *t*, rearranging and taking into account (17) we get:

$$\frac{d}{dt}E[\tilde{\pi}] = \left[q(\tilde{P}-C+\lambda)+(1-q)(\tilde{P}-C-\lambda)\right]\frac{d\tilde{x}}{dt}$$
$$+\left[q(\tilde{P}-C-t+\lambda)+(1-q)(\tilde{P}-C-t-\lambda)\right]\frac{d\tilde{x}^{\circ}}{dt}. \qquad (27)$$

Finally, the change of the expected producer surplus with response to change in transportation cost can be represented as

$$\frac{d}{dt}E[PS] = \frac{1}{(\tilde{x}+\tilde{x}^{\circ})^2}\left\{\frac{dD}{dP}(\tilde{P})\tilde{x}^{\circ}E[\tilde{\pi}] + D(\tilde{P})\left(\frac{d\tilde{x}}{dt}\tilde{x}^{\circ} - \tilde{x}\frac{d\tilde{x}^{\circ}}{dt}\right)t\right\}, \qquad (28)$$

where $E[\tilde{\pi}]$ is given by (26). Thus, the pattern of changes in the expected producer surplus increases in response to changes in transportation cost, depends on the shape of demand curve. In particular, expected producer surplus falls as transportation cost increases if

$$\frac{\left(\frac{d\tilde{x}}{dt}\tilde{x}^{\circ} - \tilde{x}\frac{d\tilde{x}^{\circ}}{dt}\right)t}{\tilde{x}^{\circ}E[\tilde{\pi}]} < -\frac{\frac{dD}{dP}(\tilde{P})}{D(\tilde{P})} \qquad (29)$$

i.e., if

a. market demand is very elastic (inverse demand curve is flat),

or/and

b. per unit transportation cost is negligable (t is close to zero).

<u>Total effect.</u> Under free trade expected welfare is a sum of expected consumer and producer surplus. Consequently, the change in total expected welfare in response to change in transportation cost is determined as

$$\frac{d}{dt}E[W] = -D(\tilde{P})\frac{\tilde{x}^{\circ}}{\tilde{x}+\tilde{x}^{\circ}} + \frac{1}{(\tilde{x}+\tilde{x}^{\circ})^2}\left\{\frac{dD}{dP}(\tilde{P})\tilde{x}^{\circ}E[\tilde{\pi}] + D(\tilde{P})\left[\left(\frac{d\tilde{x}}{dt}\tilde{x}^{\circ} - \tilde{x}\frac{d\tilde{x}^{\circ}}{dt}\right)t\right]\right\}. \qquad (30)$$

Thus, total expected welfare decreases if transportation cost increases if

$$\frac{\left[\left(\frac{d\tilde{x}}{dt}\tilde{x}^{\circ} - \tilde{x}\frac{d\tilde{x}^{\circ}}{dt}\right)\cdot t\right]/\tilde{x}^{\circ} - (\tilde{x}+\tilde{x}^{\circ})}{E[\tilde{\pi}]} < -\frac{\frac{dD}{dP}(\tilde{P})}{D(\tilde{P})} \qquad (31)$$

i.e., if

a. market demand is very elastic (inverse demand curve is flat), or/and

b. per unit transportation cost is negligable (t is close to zero).

It follows from the analysis above that decrease in transportation costs, which allows countries to extend international exchange, improves welfare if market demand is elastic enough.

4 Contagion Effect

4.1 A simple model

Suppose now that transportation cost are so small that can be neglected (i.e., assume transportation cost $t=0$) and consider two non necessarily identical countries: Home and foreign. As in the analysis above assume that two states of nature *S1* and *S2* can occur independently in both countries. In the home country state *S1* occurs with probability q and is characterized by an inverse demand curve $\overline{P} = A - BX + \overline{\lambda}$, and state *S2* occurs with probability $(1-q)$ and inverse demand curve in this state is specified as $\underline{P}=A-BX-\underline{\lambda}$. In the foreign country state *S1* occurs with probability q^* and inverse demand curve in this state is specified as $\overline{P}^* = A^* - B^*X^* + \overline{\lambda}^*$, and state *S2* occurs with probability $(1-q^*)$ and is characterized by an inverse demand curve $\underline{P}^*=A^*-B^*X^*-\underline{\lambda}^*$ $(A,\ A^*, B,\ B^*, \overline{\lambda}, \overline{\lambda}^*, \underline{\lambda}, \underline{\lambda}^* > 0)$.[6]

Moreover, we assume that firms in both markets are identical and their cost structure is such as described in Section 2.2. Since $t=0$, the situation in the countries considered is symmetric in the sense that

a. part of home firm output supplied to the domestic market ($\tilde{x}$) equals to exported part of foreign firm output ($\tilde{x}^{\circ *}$);

b. part of foreign firm output supplied to the domestic market ($\tilde{x}^*$) equals to exported part of home firm output ($\tilde{x}^\circ$);

c. the number of firms in both markets is the same (i.e., $\tilde{N} = \tilde{N}^*$).

Therefore, market equilibrium is characterized by the triple ($\tilde{x}, \tilde{x}^\circ, \tilde{N}$), which could be determined from the set of equations (13)-(15). That is, to determine equilibrium values it is enough to focus on a single market (in particular, in the considerations which follows we focus on the home market), where

[6] All variables related to the foreign country are denoted by superscript *

$$E\left[U(\pi)\right] \equiv qq^{*}U(\pi_1) + q(1-q^{*})U(\pi_2) + q^{*}(1-q)U(\pi_3) + (1-q)(1-q^{*})U(\pi_4) \tag{32}$$

and

$$\pi_1(x, x^{\circ}) = \overline{P}x + \underline{P}^{*}x^{\circ} - C(x + x^{\circ}), \tag{33}$$

$$\pi_2(x, x^{\circ}) = \overline{P}x + \underline{P}^{*}x^{\circ} - C(x + x^{\circ}), \tag{34}$$

$$\pi_3(x, x^{\circ}) = \underline{P}x + \overline{P}^{*}x^{\circ} - C(x + x^{\circ}), \tag{35}$$

$$\pi_4(x, x^{\circ}) = \underline{P}x + \underline{P}^{*}x^{\circ} - C(x + x^{\circ}). \tag{36}$$

To simplify the analysis assume that the exact shape of the utility function U is specified as follows:

$$U(\pi) = \begin{cases} d\pi, \quad \textit{if} \quad \pi < \Pi_3 \\ c\pi + (d-c)\Pi_3, \quad \textit{if} \quad \Pi_3 < \pi < \Pi_2 \\ b\pi + (c-b)\Pi_2 + (d-c)\Pi_3, \quad \textit{if} \quad \Pi_2 < \pi < \Pi_1 \\ a\pi + (b-a)\Pi_1 + (c-b)\Pi_2 + (d-c)\Pi_3, \quad \textit{if} \quad \Pi_1 < \pi \end{cases} \tag{37}$$

where $0<a<b<c<d$ and the output of the firm is such that $\pi_4<\Pi_3<\pi_3<\Pi_2<\pi_2<\Pi_1<\pi_1$ (see Fig.1).[7]

Taking into account (33-37) and solving (13)-(14) with respect to x and x° (assuming that firms are price takers) we get equilibrium volumes supplied by home country firms to domestic market and exported:

$$Q_E^{\;*} = Q_I = N\tilde{x} = \frac{A-C}{2B} + \frac{\overline{\lambda}[qq^{*}a + q(1-q^{*})b] - \underline{\lambda}[q^{*}(1-q)c + (1-q)(1-q^{*})d]}{2B[qq^{*}a + q(1-q^{*})b + q^{*}(1-q)c + (1-q)(1-q^{*})d]} \tag{38}$$

$$Q_E = Q_I^{*} = N\tilde{x}^{\circ} = \frac{A^{*}-C}{2B^{*}} + \frac{\overline{\lambda}^{*}[qq^{*}a + q^{*}(1-q)c] - \underline{\lambda}^{*}[q(1-q^{*})b + (1-q)(1-q^{*})d]}{2B^{*}[qq^{*}a + q(1-q^{*})b + q^{*}(1-q)c + (1-q)(1-q^{*})d]} \tag{39}$$

where Q_E, Q_E^{*} denote the volume of home and foreign country export, and Q_I, Q_I^{*} stand for the volume of home and foreign country import, respectively.

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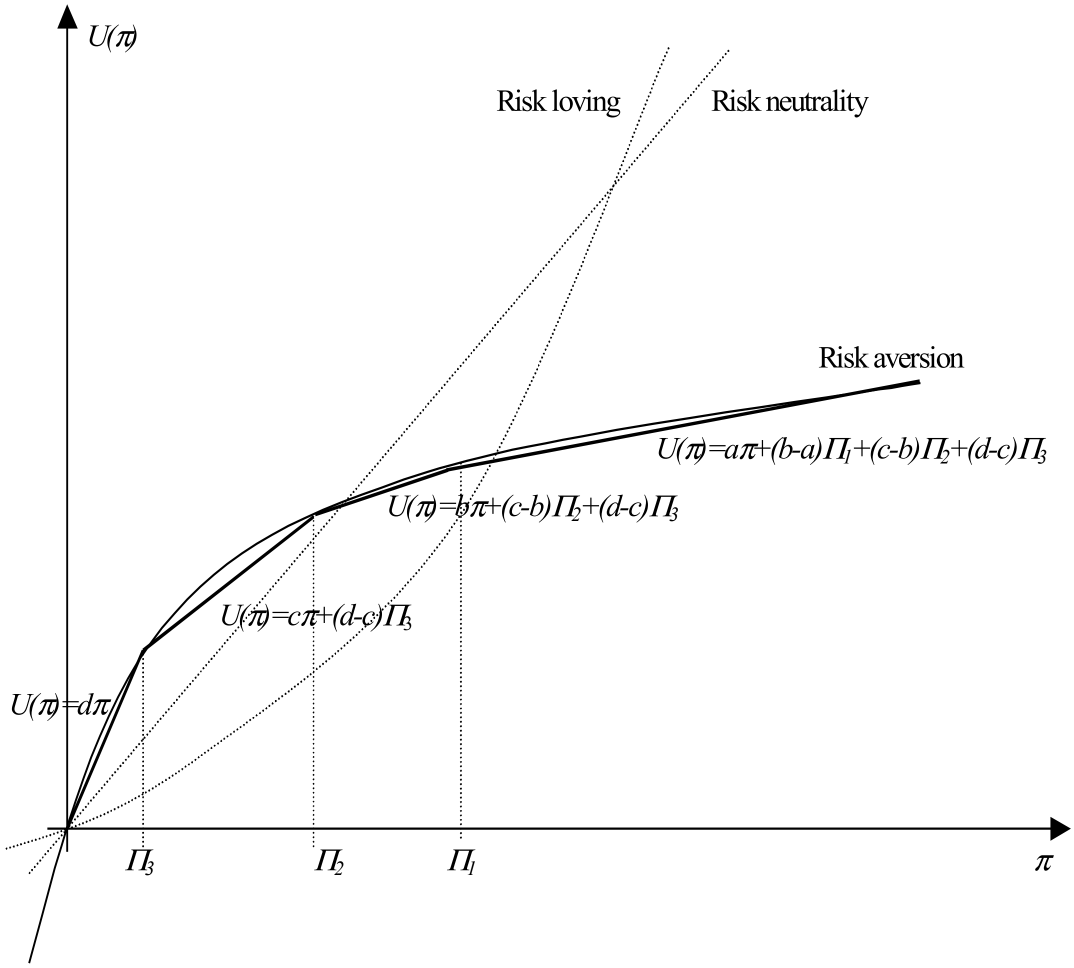
[7] Note that function (37) is concave but not strictly concave, nevertheless, due to the assumption about the distribution of profits we do not restrict generality.

Fig. 1. Formal description of the firm's attitude to risk (risk averse utility function is represented using piecewise approximation)



4.2 Misinterpretation of expected demand

Now assume that due to the turmoil in neighbor countries economic agents change interpretation of existing foreign market information (i.e., the perception of the distribution of market demand in foreign country). In particular, assume that firms expect that the downward shift from the expected demand in foreign country will be larger, i.e., that $\underline{\lambda}^*$ increases.[8] As the result, the volume of foreign country import decreases, i.e., $dQ_I^* / d\underline{\lambda}^* < 0$ (it is straightforward from (39)). However, if the basic macroeconomic fundamentals in the country have not been affected by the crises and true distribution of the demand remains unchanged, the shift in the perception of the distribution of market demand has important macroeconomic consequences. In particular, due to lower import (and also lower domestic supply to foreign market) the total volume of output supplied to foreign

[8] Alternatively, one can assume that firms change their expectation concerning the probability of downward shift from the expected demand in foreign country, i.e., that q^* decreases.

country market decreases, and as the result the market price is higher than it would be otherwise. Higher import price worsen foreign country terms of trade, i.e., foreign country is now worse off, since for the same amount of export can import less.

Since the situation in the home country market does not change (the value of foreign country export is not affected) the effect of the change considered on foreign country balance of trade (TB^*) is determined by the change in the value of foreign country import. Thus, the change in the expected foreign country balance of trade equals

$$\frac{\partial}{\partial \underline{\lambda}^*} E[TB^*] = q^* \frac{\partial \overline{TB}^*}{\partial \underline{\lambda}^*} + (1-q^*) \frac{\partial \underline{TB}^*}{\partial \underline{\lambda}^*}, \tag{40}$$

where

$$\frac{\partial}{\partial \underline{\lambda}^*} \overline{TB}^* = \frac{\partial \overline{P}^*}{\partial \underline{\lambda}^*} Q_I^* + \overline{P}^* \frac{\partial Q_I^*}{\partial \underline{\lambda}^*} = -2B^* \frac{\partial Q_I^*}{\partial \underline{\lambda}^*} Q_I^* + \left(A^* - 2B^* Q_I^* + \overline{\lambda}^*\right) \frac{\partial Q_I^*}{\partial \underline{\lambda}^*}, \tag{41}$$

$$\frac{\partial}{\partial \underline{\lambda}^*} \underline{TB}^* = \frac{\partial \underline{P}^*}{\partial \underline{\lambda}^*} Q_I^* + \underline{P}^* \frac{\partial Q_I^*}{\partial \underline{\lambda}^*} = -2B^* \frac{\partial Q_I^*}{\partial \underline{\lambda}^*} Q_I^* + \left(A^* - 2B^* Q_I^* - \underline{\lambda}^*\right) \frac{\partial Q_I^*}{\partial \underline{\lambda}^*}. \tag{42}$$

It follows from (40)-(42) that the expected foreign country balance of trade deteriorates if $Q_I^* > A^*/4B^*$, i.e., if

$$\frac{A^*}{2} + \frac{\overline{\lambda}^*[qq^*a + q^*(1-q)c] - \underline{\lambda}^*[q(1-q^*)b + (1-q)(1-q^*)d]}{2B^*[qq^*a + q(1-q^*)b + q^*(1-q)c + (1-q)(1-q^*)d]} > C. \tag{43}$$

Furthermore, assuming that the number of employees in the industry increases with the volume of output produced, one can conclude that misinterpretation of expected market demand will rise unemployment in both: home and foreign country. Therefore, the change in the perception of market conditions in the foreign country may affect the situation in the home country as well (note that is the condition (43) is not satisfied trade balance in the home country is deteriorated).

4.3 An increase in the variability of demand

Similar to the analysis above assume that due to the turmoil in neighbour countries economic agents changed interpretation of existing foreign market information. In particular assume, that the expected demand remains unchanged but the variability of demand changes. To simplify the analysis assume that in the foreign country probabilities of both possible states of nature are equal, and upward and downward shifts from the expected demand are identical, i.e., $\lambda = \underline{\lambda}^* = \overline{\lambda}^*$.

Furthermore, assume that due to the turmoil in neighbor countries shifts from the expected demand increase (i.e., λ^* increases).

It follows from (39) that as the result, the volume of the foreign country import decreases[9], i.e., $dQ_I^* / d\lambda^* < 0$. Consequently, the total volume of output supplied to the foreign country market decreases (unemployment in both countries rises), and market price in the foreign country is higher than it would be otherwise. Higher import price worsens the foreign country terms of trade. Since

$$\frac{\partial}{\partial \lambda^*}\overline{TB}^* = \frac{\partial \overline{P}^*}{\partial \lambda^*}Q_I^* + \overline{P}^*\frac{\partial Q_I^*}{\partial \lambda^*} = (-2B^*\frac{\partial Q_I^*}{\partial \lambda^*} + 1)Q_I^* + \left(A^* - 2B^*Q_I^* + \lambda^*\right)\frac{\partial Q_I^*}{\partial \lambda^*}, \tag{44}$$

$$\frac{\partial}{\partial \lambda^*}\underline{TB}^* = \frac{\partial \underline{P}^*}{\partial \lambda^*}Q_I^* + \underline{P}^*\frac{\partial Q_I^*}{\partial \lambda^*} = (-2B^*\frac{\partial Q_I^*}{\partial \lambda^*} - 1)Q_I^* + \left(A^* - 2B^*Q_I^* - \lambda^*\right)\frac{\partial Q_I^*}{\partial \lambda^*}, \tag{45}$$

the expected foreign country balance of trade deteriorates if $Q_I^*>A^*/(4B^*-1)$, otherwise the expected foreign country balance of trade improves and the expected home country balance of trade deteriorates.

5 Conclusions

The analysis we have just gone through shows that there is some justification for crises propagation through international trade channels based on the change in expectations concerning market conditions, even if exchange rate is not affected. To explore trade roots of contagion effects we focused on the trade mechanism which appears to be useful in understanding trade among industrial countries. In particular, we considered international trade in identical goods between the countries with perfectly competitive markets (as in the European Union, for example). International exchange of identical commodities (cross-hauling) occurs due to the fact that risk averse firms operating in perfectly competitive markets with price uncertainty tend to diversify markets. If transportation costs are small enough this gives a basis for international trade between identical countries. The paper demonstrates that if firms do act in each competitive market separately, international trade in identical commodities can arise and also, that such trade may be welfare improving (even despite the existence of cross-hauling which is obviously inefficient due to costly transportation). Moreover, the analysis of the two country world shows that change in the perception of market conditions in one country changes results in smaller volume of output supplied to this market, higher price level (inflation), worsens terms of trade of this country, rises unemployment, and affects the trade balance. All of this can destabilize the macroeconomic

9 Note that risk aversion implies that $\lambda^*[qq^*a + q^*(1-q)c - q(1-q^*)b - (1-q)(1-q^*)d]$ is negative.

situation in the country even if initially macroeconomic fundamentals were not affected by the crises.

The results of the analysis are especially important for countries operating on a single currency market (such as the European Union), since, in contrary to the main stream of economic literature, they explain the mechanism of crises propagation through international trade channel even in case when exchange rate is not affected. The results suggest that new entrants to the European Community having weaker macroeconomic conditions than incumbent countries with strong trade links with emerging markets (i.e., with the countries from outside EU, e.g., from Commonwealth of Independent States) can be easily affected by the crises from outside. An important issue is that the impetus for economic destabilization can be given exclusively by the shift in the perception of the market conditions resulting from disturbances in other countries. A single currency and economic mechanisms of the European Union can obviously reduce the consequences of the crises but cannot fully prevent the contagion effect.

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